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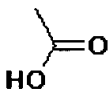
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Amino Acids

An **AMINO ACID** is by definition an organic compound containing an amine group —NH_2 and a



carboxylic **acid** group in the same molecule. While there are many forms of **amino** acids, all of the important **amino** acids found in living organisms are **alpha-amino** acids. **Alpha amino** acids have the —COOH and —NH_2 groups both attached to the same carbon atom, called the **alpha** carbon atom. The simplest **amino acid**, which is the molecule glycine, $\text{H}_2\text{NCH}_2\text{COOH}$, contains no asymmetric carbon atoms (tetrahedral carbon atoms with four different groups attached). All of the other **amino** acids do contain such a carbon atom and are therefore optically active. The general structure of the **alpha-amino** acids is $\text{R—CHNH}_2(\text{alpha})\text{—COOH}$, and optical activity for the **alpha-amino** acids more complex than glycine is found at the **alpha** carbon. The **amino** acids which have been found to be incorporated into the proteins of living organisms are listed in the Table below.

Table: **Amino** Acids Found to Be Incorporated Into Proteins

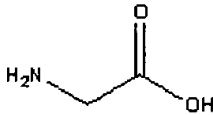
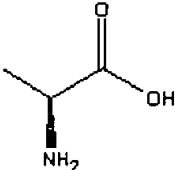
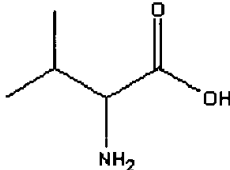
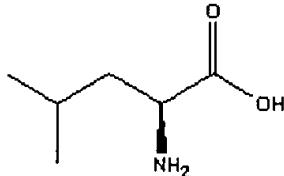
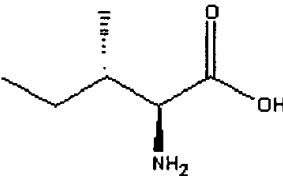
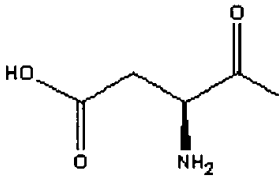
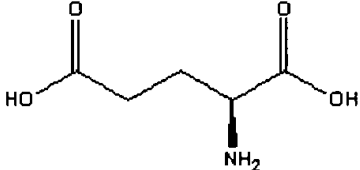
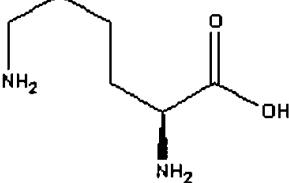
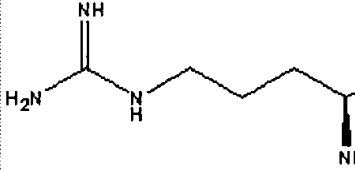
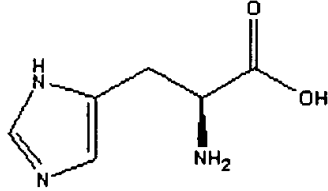
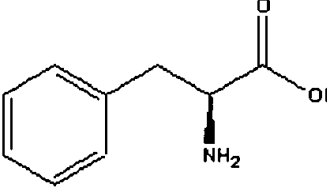
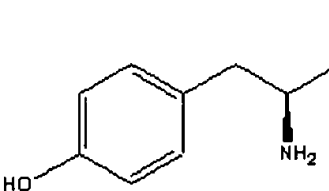
Name (Abb.)	R Group	Class	Synthesis
glycine (Gly)	H—	hydrocarbon	yes
alanine (Ala)	$\text{CH}_3\text{—}$	hydrocarbon	yes
valine (Val)	$(\text{CH}_3)_2\text{CH—}$	hydrocarbon	no
leucine (Leu)	$(\text{CH}_3)_2\text{CH}_2\text{CH}_2\text{—}$	hydrocarbon	no
isoleucine (Ile)	$\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{—}$	hydrocarbon	no
aspartic acid (Asp)	$\text{HOOCCH}_2\text{—}$	acidic	yes
glutamic acid (Glu)	$\text{HOOCCH}_2\text{CH}_2\text{—}$	acidic	yes
lysine (Lys)	$\text{H}_2\text{N}(\text{CH}_2)_4\text{—}$	basic	no
arginine (Arg)	$\text{HN}=\text{C}(\text{NH}_2)\text{NH}(\text{CH}_2)_3\text{—}$	basic	no
histidine* (His)	ring structure	basic	no
phenylalanine (Phe)	$\text{C}_6\text{H}_5\text{CH}_2\text{—}$	aromatic	no
tyrosine* (Tyr)	$\text{HOC}_6\text{H}_5\text{CH}_2\text{—}$	aromatic	yes
tryptophan* (Trp)	ring structure	aromatic	no
serine (Ser)	$\text{HOCH}_2\text{—}$	alcohol	yes
threonine (Thr)	$\text{HOCH}(\text{CH}_3)\text{—}$	alcohol	no
methionine (Met)	$\text{H}_3\text{CSCH}_2\text{CH}_2\text{—}$	sulfur	no
cysteine (Cys)	$\text{HSCH}_2\text{—}$	sulfur	no
asparagine (Asp)	$\text{H}_2\text{NCOCH}_2\text{—}$	amide	yes

glutamine (Gln)	H ₂ NCOCH ₂ CH ₂ -	amide	yes
proline* (Pro)	heterocyclic ring	unique	yes

Note: the hydroxyl group is para on the ring in tyrosine.

AMINO ACIDS have both an acidic group, in the carboxylic **acid**, and a basic group, in the amine. Under physiological aqueous conditions a proton transfer from the **acid** to the base occurs, forming a dipolar ion or zwitterion, because the carboxylic **acid** is a much stronger **acid** than is the ammonium ion. The actual structure of glycine in solution, for example, is $^+H_3NCH_2COO^-$ at pH 7 rather than H_2NCH_2COOH . At very low pH the **acid** group can be protonated and at very high pH the ammonium group can be deprotonated, but the forms of **amino** acids relevant to living organisms are the zwitterions.

Each asymmetric carbon gives rise to two optical isomers which are traditionally distinguished by the letters D or L. Only those **amino** acids which are the L forms (left-handed) at the **alpha** carbon are found in terrestrial life.

 <p>glycine (Gly)</p>	 <p>alanine (Ala)</p>	 <p>valine (Val)</p>
 <p>leucine (Leu)</p>	 <p>isoleucine (Ile)</p>	 <p>aspartic acid (Asp)</p>
 <p>glutamic acid (Glu)</p>	 <p>lysine (Lys)</p>	 <p>arginine (Arg)</p>
 <p>histidine* (His)</p>	 <p>phenylalanine (Phe)</p>	 <p>tyrosine* (Tyr)</p>